Claims

1.   Method for optimizing the sequence order of optical passive filters in WDM (Wavelength Division Multiplex) multi-channel transmission systems, said optical passive filters making up mux/demux structures at nodes of the WDM system,

wherein the sequence order of the optical passive filters is determined depending on the attenuation profile and variations of the insertion loss profile of the WDM system, in order to maximise the minimum span length between nodes.

2.   Method according to claim 1, wherein said method comprises the following steps:

- setting a number of parameters identifying the WDM system;

- defining the attenuation profile over the channels of the WDM system, by using said parameters;

- determining the order sequence of channels in the mux/demux from the attenuation profile;

- determining the insertion loss profile of the different channels from that sequence;

- determining the minimum span length between nodes resulting from applying said channel sequence.

3.   Method according to claim 2, wherein the step of determining the insertion loss profile of the different channels from that sequence is made for different numbers of intermediate non-regenerative nodes, from no nodes to a given maximum.

4.   Method according to claim 3, wherein the parameters identifying the WDM system are:

- Number of channels: **N;**

- Set of wavelengths: $\lambda_1...\lambda_N$ [nm] of the N channels;

- Fiber loss profile: $F_{loss}(\lambda)$ [dB/km] of the optical fibre used in the WDM system;

- Insertion loss model: I_{loss1}, and Δ_{att} [dB] of the mux/demux structure, where I_{loss} value gives the losses measured between the input (common) port and the N outputs: $I_{loss}(n) = I_{loss1} + \Delta_{att}(n-1)$, I_{loss1} is the insertion loss of the first port of

the structure; Δ_{att} is the incremental attenuation between to adjacent ports of the structure; **n** is the port position;

- Span length target: **Slt** [km] as required for the WDM system;

- Power Budget: **Pb** [dB] used between the nodes of the WDM system;

- Intermediate nodes: **Inodes,** maximum number of intermediate non-regenerative nodes.

5. Method according to claim 4, wherein the step of defining the attenuation profile over the channels of the WDM system, comprises:

- substituting each wavelength of the vector $\lambda_1...\lambda_N$ in the attenuation profile $F_{loss}(\lambda)$;

- getting the specific attenuation coefficient vector for each channel of the system $Ac_1...Ac_N$ [db/km] $= F_{loss}(\lambda_1...\lambda_N)$ [dB];

- multiplying the $Ac_1...Ac_N$ vector for the span length target **Slt** to get the fiber attenuation vector $Fatt(\lambda_1)... Fatt(\lambda_N) = Slt * Ac_1...Ac_N$ [dB];

- determining the maximum attenuation of the vector $Fatt(\lambda_1)... Fatt(\lambda_N)$:

$Mav = max [Fatt(\lambda_1)... Fatt(\lambda_N)]$ [dB];

- normalizing the vector $Fatt(\lambda_1)... Fatt(\lambda_N)$ with the subtraction:

$Att(\lambda_i) = Mav - Fatt(\lambda_i)$ [dB];

- ordering from zero to the highest value of attenuation to get a vector with non-negative increasing values, describing the shaping of the different attenuations of the fiber: $A_1...A_N = order [Att(\lambda_1)... Att(\lambda_N)]$ [dB];

- applying the ordering by attenuation values, to get a Lambda vector $\lambda o_1...\lambda o_N$[nm], that contains the various wavelengths with a generally non-ordered sequence.

6. Method according to claim 5, wherein the step of determining the order sequence of channels in the mux/demux from the attenuation profile comprises:

- creating the vector **Diff**, difference between two adjacent elements of **A** vector: $Diff_i = A_{i+1} - A_i$ [dB] , with $i = 1... N-1$;

- ordering and reducing the elements of **Diff** to a set of different values of attenuation (each value within a given tolerance), obtaining the vector :

$D_1 ... D_M$ [dB], with $M \leq N-1$, each value of **D** determining a mux/demux

structure having a subgroup of channels, with the following iterative calculation:

FOR i = 1 to M;

    FOR j = 1 to N - 1;

    IF [(A$_{j+1}$ − A$_j$) ≤ D(i)]

        THEN

        GROUP the channel j+1 with the channel j in the λo vector,

        ELSE

        Don't GROUP the j+1 channel with the previous one(s), it will be the first element of a new group,

    END FOR

END FOR

- using the subgroups created to build the mux-demux filter order sequence where each subgroup defines an inverted mux/demux order of channels, each subgroup having a couple of numbers, **Pinf, Psup,** between 1 and N, corresponding to the positions of the first and the last element of the subgroup.

    7.   Method according to claim 6, wherein the step of determining the insertion loss profile I.L. of the different channels comprises:

- computing, for each channel of a subgroup, the I.L. with the expression:

    λloss = I$_{loss}$ **(Pinf) + I$_{loss}$ (Psup)** [dB];

- for any number of intermediate nodes, **Inodes,** the total I.L. per channel is:

λloss * **(Inodes + 1)** [dB];

- for each channel the Span length (λ) is:

Span length (λ) = [**Pb** - λ**loss * (Inodes + 1)**] / **Ac(λ)** [km];

- the span length of the WDM system being the minimum of Span length (λ):

    Span length = min [Span length(λ$_1$...λ$_N$)] [km]

    8.   Device comprising a mux/demux structure of passive optical filters for WDM (Wavelength Division Multiplex) multi-channel transmission system, wherein the sequence order of the optical passive filters is determined depending on the attenuation profile and variations of the insertion loss profile of the WDM system, in order to maximise the minimum span length between nodes of the WDM system.

    9.   Device comprising a mux/demux structure of passive optical filters for WDM (Wavelength Division Multiplex) multi-channel transmission system,

obtained with the method of claim 1.

10. Device as in claim 8, wherein said mux/demux structure of passive optical filters is made of pass-band thin-film 3-port passive optical filters.

11. WDM (Wavelength Division Multiplex) multi-channel transmission systems comprising mux/demux structures of passive optical filters as in claim 8.

12. CWDM (Coarse Wavelength Division Multiplex) multi-channel transmission systems comprising mux/demux structures of passive optical filters as in claim 8.

13. Computer program comprising computer program code means adapted to perform all the steps of claim 1 when said program is run on a computer.

14. A computer readable medium having a program recorded thereon, said computer readable medium comprising computer program code means adapted to perform all the steps of claim 1, when said program is run on a computer.